

5 What is claimed is:

1. A method for producing a cathode active material, comprising the steps of:

- 10 (a) providing a silver vanadium compound;  
(b) mixing the silver vanadium compound with a metal salt to form a reaction mixture; and  
(c) heating the reaction mixture to at least one reaction temperature in an oxidizing atmosphere to produce an  $\epsilon$ -phase silver vanadium oxide having the formula  $\text{Ag}_2\text{V}_4\text{O}_{11}$ .

15 2. The method of claim 1 including cooling the  $\epsilon$ -phase silver vanadium oxide from the reaction temperature to an ambient temperature in an oxidizing atmosphere.

20 3. The method of claim 1 including providing the silver vanadium compound as a  $\gamma$ -phase silver vanadium oxide having the formula  $\text{Ag}_{1.2}\text{V}_3\text{O}_{8.1}$ .

25 4. The method of claim 1 including selecting the metal salt from the group consisting of silver lactate, silver triflate, silver pentafluoropropionate, silver laurate, silver myristate, silver palmitate, silver stearate, silver vanadate, silver oxide, silver carbonate, copper oxide, copper carbonate, manganese carbonate, manganese  
30 oxide, magnesium carbonate, magnesium oxide, and combinations and mixtures thereof.

5. The method of claim 1 wherein the metal salt is  $\text{Ag}_2\text{O}$  and the  $\epsilon$ -phase silver vanadium oxide has a BET  
35 surface area of about  $0.54 \text{ m}^2/\text{g}$ .

5     6.     The method of claim 1 wherein the metal salt is  
Ag<sub>2</sub>CO<sub>3</sub> and the ε-phase silver vanadium oxide has a BET  
surface area of about 0.44 m<sup>2</sup>/g.

7.     The method of claim 1 including heating the  
10     reaction mixture to the at least one reaction  
temperature in a range from about 300°C. to about 550°C.

8.     The method of claim 1 including heating the  
reaction mixture to the at least one reaction  
15     temperature for about 5 hours to about 30 hours.

9.     A method for providing a cathode electrode,  
comprising the steps of:

- 20            (a)     providing γ-phase silver vanadium oxide having  
the formula Ag<sub>1.2</sub>V<sub>3</sub>O<sub>8.1</sub>;
- (b)     mixing the γ-phase silver vanadium oxide with a  
metal salt to form a reaction mixture;
- (c)     heating the reaction mixtures to at least one  
25            reaction temperature in an oxidizing  
atmosphere to produce an electrode active  
material selected from the group consisting of  
Ag<sub>2</sub>V<sub>4</sub>O<sub>11</sub>, Cu<sub>0.2</sub>Ag<sub>0.8</sub>V<sub>2</sub>O<sub>5.6</sub>, Mn<sub>0.2</sub>Ag<sub>0.8</sub>V<sub>2</sub>O<sub>5.8</sub> and  
Mg<sub>0.2</sub>Ag<sub>0.8</sub>V<sub>2</sub>O<sub>5.6</sub>; and
- 30            (d)     utilizing the electrode active material in a  
cathode electrode.

10.     The method of claim 9 including cooling the  
electrode active material from the reaction temperature  
to an ambient temperature in an oxidizing atmosphere.

35     11.     The method of claim 9 including selecting the metal

5 salt from the group consisting of silver lactate, silver  
triflate, silver pentafluoropropionate, silver laurate,  
silver myristate, silver palmitate, silver stearate,  
silver vanadate, silver oxide, silver carbonate, copper  
oxide, copper carbonate, manganese carbonate, manganese  
10 oxide, magnesium carbonate, magnesium oxide, and  
combinations and mixtures thereof.

12. The method of claim 9 including providing the metal  
salt as  $\text{Ag}_2\text{O}$  such that the product  $\text{Ag}_2\text{V}_4\text{O}_{11}$  has a BET  
15 surface area of about  $0.54 \text{ m}^2/\text{g}$ .

13. The method of claim 9 including providing the metal  
salt as  $\text{Ag}_2\text{CO}_3$  such that the product  $\text{Ag}_2\text{V}_4\text{O}_{11}$  has a BET  
surface area of about  $0.44 \text{ m}^2/\text{g}$ .

20 14. The method of claim 9 including providing the metal  
salt as  $\text{CuO}$  such that the product  $\text{Cu}_{0.2}\text{Ag}_{0.8}\text{V}_2\text{O}_{5.6}$  has a  
BET surface area of about  $0.31 \text{ m}^2/\text{g}$ .

25 15. The method of claim 9 including heating the  
reaction mixture to the at least one reaction  
temperature in a range from about  $300^\circ\text{C}$ . to about  $550^\circ\text{C}$ .

16. The method of claim 9 including heating the  
30 reaction mixture to the at least one reaction  
temperature for a period of about 5 hours to about 30  
hours.

17. The method of claim 9 wherein the step of utilizing  
35 the electrode active material to form the cathode  
electrode includes the addition of a binder and a  
conductive material.

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18. The method of claim 16 wherein the cathode electrode further comprises about 0 to about 3 weight percent of a carbonaceous conductive additive, about 0 to about 3 weight percent of a fluoro-resin powder, and  
10 about 94 to about 99 weight percent of the electrode active material.

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19. A cathode for an electrochemical cell, the cathode comprising an  $\epsilon$ -phase silver vanadium oxide  
characterized as prepared by heating a silver vanadium compound mixed with a metal salt to form a reaction mixture heated to at least one reaction temperature in an oxidizing atmosphere to produce the  $\epsilon$ -phase silver vanadium oxide having the formula  $\text{Ag}_2\text{V}_4\text{O}_{11}$ .

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20. The cathode of claim 19 wherein the silver vanadium compound is  $\gamma$ -phase silver vanadium oxide having the formula  $\text{Ag}_{1.2}\text{V}_3\text{O}_{8.1}$ .

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21. The cathode of claim 19 wherein the metal salt is selected from the group consisting of silver lactate, silver triflate, silver pentafluoropropionate, silver laurate, silver myristate, silver palmitate, silver stearate, silver vanadate, silver oxide, silver  
30 carbonate, copper oxide, copper carbonate, manganese carbonate, manganese oxide, magnesium carbonate, magnesium oxide, and combinations and mixtures thereof.

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22. The cathode of claim 19 wherein the metal salt is  $\text{Ag}_2\text{O}$  and the  $\epsilon$ -phase silver vanadium oxide has a BET surface area of about  $0.54 \text{ m}^2/\text{g}$ .

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23. The cathode of claim 19 wherein the metal salt is  $\text{Ag}_2\text{CO}_3$  and the  $\epsilon$ -phase silver vanadium oxide has a BET surface area of about  $0.44 \text{ m}^2/\text{g}$ .

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24. The cathode of claim 19 wherein the reaction mixture is heated to the at least one reaction temperature in a range from about  $300^\circ\text{C}$  to about  $550^\circ\text{C}$ .

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25. The cathode of claim 19 wherein the reaction mixture is heated to the at least one reaction temperature for about 5 hours to about 30 hours.

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26. The cathode of claim 19 further comprising a binder and a conductive material.

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27. A cathode for an electrochemical cell, the cathode comprising an electrode active material characterized as prepared from  $\gamma$ -phase silver vanadium oxide having the formula  $\text{Ag}_{1.2}\text{V}_3\text{O}_{8.1}$  mixed with a metal salt compound to form a reaction mixture heated to at least one reaction temperature in an oxidizing atmosphere to produce the electrode active material selected from the group consisting of  $\text{Ag}_2\text{V}_4\text{O}_{11}$ ,  $\text{Cu}_{0.2}\text{Ag}_{0.8}\text{V}_2\text{O}_{5.6}$ ,  $\text{Mn}_{0.2}\text{Ag}_{0.8}\text{V}_2\text{O}_{5.8}$ , and  $\text{Mg}_{0.2}\text{Ag}_{0.8}\text{V}_2\text{O}_{5.6}$ .

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28. The cathode of claim 27 wherein the metal salt is selected from the group consisting of silver lactate, silver triflate, silver pentafluoropropionate, silver laurate, silver myristate, silver palmitate, silver stearate, silver vanadate, silver oxide, silver carbonate, copper oxide, copper carbonate, manganese carbonate, manganese oxide, magnesium carbonate,

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5 magnesium oxide, and combinations and mixtures thereof.

29. The cathode of claim 27 wherein the metal salt is  
Ag<sub>2</sub>O such that the product electrode active material  
having the formula Ag<sub>2</sub>V<sub>4</sub>O<sub>11</sub> has a BET surface area of  
10 about 0.54 m<sup>2</sup>/g.

30. The cathode of claim 27 wherein the metal salt is  
Ag<sub>2</sub>CO<sub>3</sub> such that the product electrode active material  
having the formula Ag<sub>2</sub>V<sub>4</sub>O<sub>11</sub> has a BET surface area of  
15 about 0.44 m<sup>2</sup>/g.

31. The cathode of claim 27 wherein the metal salt is  
CuO such that the product electrode active material  
having the formula Cu<sub>0.2</sub>Ag<sub>0.8</sub>V<sub>2</sub>O<sub>5.6</sub> has a BET surface area  
20 of about 0.31 m<sup>2</sup>/g.

32. A nonaqueous electrochemical cell, comprising:  
    (a) an anode;  
    (b) a cathode containing an active material  
25 comprising an ε-phase silver vanadium oxide  
compound characterized as having been prepared  
from a mixture of a silver vanadium compound  
and a metal salt forming a reaction mixture  
heated to at least one reaction temperature in  
30 an oxidizing atmosphere to produce the ε-phase  
silver vanadium oxide having the formula  
Ag<sub>2</sub>V<sub>4</sub>O<sub>11</sub>;  
    (c) a non-aqueous electrolyte activating the anode  
and the cathode; and  
35 (d) a separator material electrically insulating  
the anode from the cathode, and of a porosity

5 to allow for electrolyte flow.

33. The electrochemical cell of claim 32 wherein the anode is comprised of lithium.

10 34. The electrochemical cell of claim 32 wherein the silver vanadium containing compound is  $\gamma$ -phase silver vanadium oxide having the formula  $\text{Ag}_{1.2}\text{V}_3\text{O}_{8.1}$ .

15 35. The electrochemical cell of claim 32 wherein the metal salt is selected from the group consisting of silver lactate, silver triflate, silver pentafluoropropionate, silver laurate, silver myristate, silver palmitate, silver stearate, silver vanadate, silver oxide, silver carbonate, copper oxide, copper  
20 carbonate, manganese carbonate, manganese oxide, magnesium carbonate, magnesium oxide, and combinations and mixtures thereof.

25 36. The electrochemical cell of claim 32 wherein the metal salt is  $\text{Ag}_2\text{O}$  and the  $\epsilon$ -phase silver vanadium oxide has a BET surface area of about  $0.54 \text{ m}^2/\text{g}$ .

30 37. The electrochemical cell of claim 32 wherein the metal salt is  $\text{Ag}_2\text{CO}_3$  and the  $\epsilon$ -phase silver vanadium oxide has a BET surface area of about  $0.44 \text{ m}^2/\text{g}$ .

35 38. The electrochemical cell of claim 32 wherein the reaction mixture is heated to the at least one reaction temperature in a range from about  $300^\circ\text{C}$  to about  $550^\circ\text{C}$ .

39. The electrochemical cell of claim 32 wherein the

- 5 reaction mixture is heated to the at least one reaction temperature for about 5 hours to about 30 hours.

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